Int J Life Cycle Assess (2014) 19:463–470
DOI 10.1007/s11367-013-0682-1

CONFERENCE REPORT

# Linking research activities and their implementation in practice in the construction sector: the LCA Construction 2012 experience

**Sébastien Lasvaux · Anne Ventura · Guillaume Habert · Chantal De La Roche · Kristel Hermel · Adélaïde Feraille · Yannick Tardivel · Christian Tessier**

Received: 3 December 2013 / Accepted: 4 December 2013 / Published online: 9 January 2014


## 1 Introduction

### 1.1 Background

Numerous research activities about life cycle assessment (LCA) applied to buildings, and more recently to civil engineering, have risen over the past decades. Environmental stakes are particularly important in construction because any initial decision has always long-term consequences. In addition, the construction sector both generates and recycles huge amounts of waste; it is generally considered as an important contributor to climate change and induces irreversible changes in local environments. To face these stakes, industries invest into so-called "green innovations", and national or local public authorities are demanding scientifically based decision support such as LCA. For the time being, LCA research appears to be fragmented between LCA practitioners in various construction fields and LCA methodologists. However, LCA practitioners in the construction sector share identical methodological questions. For example, drastic variations, which inevitably occur between the early and operational stages of construction projects, have led many research institutions to develop their own dedicated LCA software tools. These tools are, however, seldom comparable, since they generally use different databases and assumptions. Only close cooperation between LCA methodologists and construction scientists can lead to appropriate methodological developments.

To better link LCA research activities and their implementation in practice in the construction sector, the idea of organizing a forum of discussions of recent developments and research results was launched in 2011 by IFSTTAR (the French Institute for Transport, Development and Networks) on the topics of LCA, recycling, and civil engineering. It was then expanded to LCA and buildings when CSTB (the French Scientific and Technical Centre for Buildings) joined the initiative. This idea leads to the organization of the first international conference on LCA and Construction with a focus on civil engineering and buildings.

### 1.2 LCA and construction activities

Using LCA in the construction activities has different goals and scopes due to the different scales of the assessment

S. Lasvaux
Scientific and Technical Centre for Buildings (CSTB), University Paris-East, Paris, France

A. Ventura (✉)
Chaire Eco-Construction, GeM Laboratory, University of Nantes-Angers-Le Mans (UNAM), 44603 Saint-Nazaire Cedex, France
e-mail: anne.ventura@univ-nantes.fr

G. Habert
ETH Zurich, Institute for Construction and Infrastructure Management, 8092 Zurich, Switzerland

C. De La Roche
Materials Department, IFSTTAR, University of Nantes-Angers-Le Mans (UNAM), Nantes Angers, Le Mans, France

K. Hermel
IFSTTAR, University Paris-East, Paris, France

A. Feraille
Navier Laboratory, Ecole des Ponts ParisTech, University Paris-East, Paris, France

Y. Tardivel
Technical Department for Transport, Roads and Bridges Engineering and Road Safety of the French Ministry of Ecology, Sustainable Development and Energy (SETRA), Paris, France

C. Tessier
Structure and Materials Department, University of Nantes-Angers-Le Mans (UNAM), Nantes Angers, Le Mans, France

(materials, constructions, or the built environment). As shown in Fig. 1, stakeholders are different with various interests (architects, contracting owners, industrials, construction companies, and public authorities), scales are different (from materials to the built environment) but interconnected, and scientific disciplines are different. Improving LCA methods applied to construction requires a trans-disciplinary approach and is indeed a challenge for moving the construction sector towards the improvement of environmental performances. The purpose of the LCA Construction 2012 conference was to gather these different fields into a forum of exchanges.

The next sections present the conference organization, the overview of the scientific presentations, and the exchanges between researchers and practitioners (invited presentations and round tables), and the summary of findings from the conference.

## 2 Presentation of LCA Construction 2012

### 2.1 Organization

The first international conference "LCA and Construction: civil engineering and buildings", organized by IFSTTAR and CSTB, took place in Nantes (France) from 10 to 12 July 2012 under the scientific auspices of three international organizations: RILEM, the International Union of Laboratories and Experts in construction materials, systems and structures, ISIE, the International Society of Industrial Ecology, and SETAC, the Society for Environmental Toxicology and Chemistry. It was also encouraged by EcoSD, the French networks of researchers and industrials in eco-design, and LirGEC, the regional network of researchers in civil engineering. The symposium benefited from the institutional partnerships of the French Ministry for Ecology, Sustainable Development and Energy, the Pays de la Loire Region and Nantes Metropole. The symposium was also sponsored by Bouygues Construction, Lafarge, Cycleco, Cimbéton, and PwC.

### 2.2 Keynotes speakers

During the opening of the symposium, IFSTTAR and CSTB gave three short introductory presentations by focusing on the challenges of LCA in the construction sector. H. Van Damme presented a general overview of the symposium, A. Ventura introduced the civil engineering challenges and J. Chevalier together with B. Peuportier (MINES ParisTech) presented an introduction of building's LCA activities. Then, three keynote speakers were invited. First, Pr. Jeroen Guinée (University of Leiden, The Netherlands) presented the different challenges of "LCA: past, present, future". Second, Pr. Arpad Horvath (University of Berkeley, USA) presented the challenges of "LCA in civil engineering". Finally Pr. Niklaus Kohler (Karlsruhe Institute of Technology, Germany) presented the challenges for "LCA of buildings".[1]

### 2.3 Scientific committee and peer-review process

This symposium aimed at grouping disparate research communities to create a forum for the exchange of recent developments amongst researchers. To gather these communities, a scientific committee was composed of more than 70 personalities from various public or private institutions, issued from more than 20 different countries. Another objective of the organizing committee of this symposium was to ensure a rigorous peer-review process for the selection of articles. Each eight-page article was reviewed by at least three different reviewers, according to their skills declared to the organizing committee. At the end of the reviewing process, 75 articles had been submitted, among which 40 were selected for oral presentation and article publication, 29 for posters and abstract publication, and 5 rejected.

### 2.4 Scientific presentations

The first 2 days were dedicated to scientific presentations. In total, 40 oral presentations and 20 posters were presented in the following topics:

- Life cycle inventory data
- Methods for buildings
- Decision and management
- LCA case studies for buildings and infrastructures
- Dynamic LCA, service life, and indicators
- Methods for construction materials
- End of life, waste, and allocations

The presentations were issued at 69 % from academics, at 22 % from private companies (professional organizations, consulting firms, etc.), and at 8 % from institutional entities (ministries and local authorities). The best article award was delivered by the scientific committee and offered by Bouygues Construction to Sarah E. Horvath and Zsuzsa Szalay from the Department of Building Constructions, Faculty of Architecture in Budapest University, for their article entitled "Decision-making case study for retrofit of high-rise concrete buildings based on life cycle assessment scenarios".

The book of proceedings including both articles of oral presentations and abstracts of posters was made available to the participants (Ventura et al. 2012). In addition, the articles related to the oral presentations are

[1] Introductory and keynote presentations can be downloaded from the website http://lcaconstruction2012.ifsttar.fr/introkeynotes.php

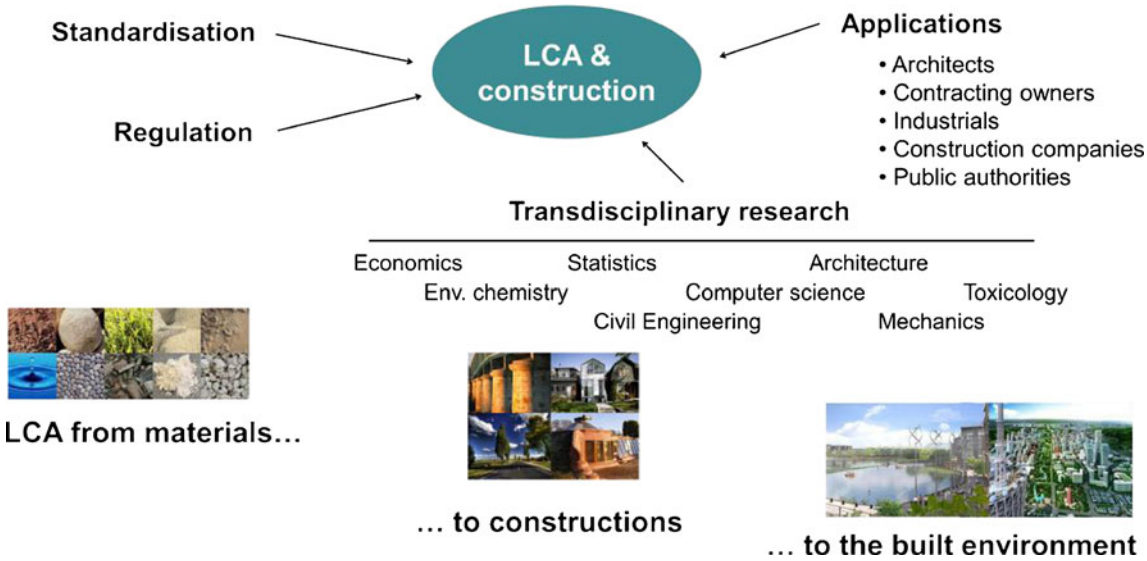


**Fig. 1** Representation of LCA and construction activities

accessible through the RILEM Proceedings online,[2] with a free registration from Rilem. The oral presentations can also be freely downloaded from the website of the symposium.[3]

### 2.5 Exchanges between researchers and practitioners

The LCA Construction 2012 symposium also aimed at providing an insight into societal demands in the construction sector during the last day. To that purpose, eight invited experts from various public or private organizations presented the latest development based on LCA on various topics such as standardization, regulations, product development, and building design. In parallel, two round tables were organized to address the following issue: "How to articulate the LCA construction research with its implementation in practice?" Thirteen experts involved in research activities and in the implementation of LCA in practice were invited at these round tables moderated by IFSTTAR and CSTB. Section 3.3 present in more detail the contents and outcomes of these presentations and round tables.

### 2.6 Participants

In total, 165 participants have attended the symposium including the following 26 countries: Austria, Belgium, Brazil, Cameroon, Canada, Croatia, Czech Republic, Denmark, Finland, France, Germany, Hungary, India, Ireland, Italy, Israel, Luxembourg, Malaysia, The Netherlands, Nigeria, Portugal, Spain, Sweden, Switzerland, UK, and the USA. Participants were issued at 38 % from academics, at 49 % from private companies, and at 10 % from institutional entities. Figure 2 presents the number of participants per country of residence. We noticed that the most represented countries were France (around 60 % of the participants) followed by the USA, Belgium, and Spain.

## 3 Overview of scientific presentations and exchanges between researchers and practitioners

### 3.1 Overview of scientific presentations

The scientific papers were presented during the following sessions: life cycle inventory data, methods for buildings, decision and management, LCA case studies for buildings and infrastructures, dynamic LCA, service life and indicators, methods for construction materials, end of life, waste, and allocations. Table 1 presents the number of presentations for each session. Generally speaking, each session has between 4

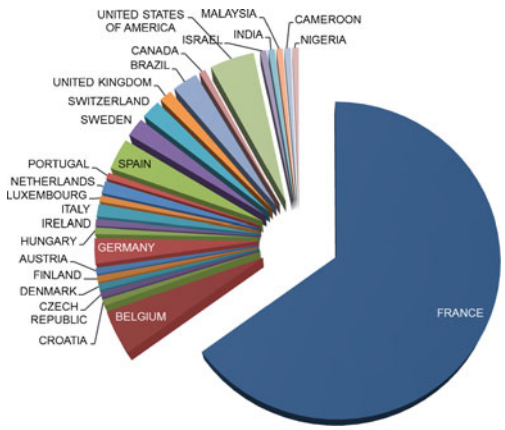


**Fig. 2** Participants for LCA construction 2012 by country of residence

[2] http://www.rilem.org/gene/main.php?base=500218&id_publication=415
[3] http://lca-construction2012.ifsttar.fr/

**Table 1** Number of oral presentations per session

| Sessions' name | |
|---|---|
| Life cycle inventory data | 4 |
| Methods for buildings | 5 |
| Decision and management | 4 |
| LCA case studies for buildings and infrastructures (2 parallel sessions) | 12 |
| Dynamic LCA, service life, and indicators | 4 |
| Methods for construction materials | 6 |
| End of life, waste, and allocations | 5 |

and 6 presentations. The only parallel sessions were the case studies' sessions for buildings and infrastructures.

We have summarized below scientific presentations outcomes for the usual steps of the LCA framework according to ISO 14040 (ISO 2006): goal and scope definition, Life Cycle Inventory (LCI), Life Cycle Impact Assessment (LCIA), and Interpretation.

Concerning the definition of the goal and scope of the study, some presentations dealt with the definition of the functional unit for buildings: do we need to account for benchmarks or reference values for buildings that have several functions? The scale of the study was also addressed during the conference. Links were identified between the different scales, i.e., from the materials to the buildings and infrastructures to urban scale.

Then, three aspects of inventory data were addressed: data quality and representativeness between different data providers, trade-offs between multisectorial and sector-specific data, and the last aspect concerned the critical issue of co-products allocations (e.g., for fly ash and blast furnace slag). A first issue concerned the convergence of calculation methods and data requirements between "academics" and "industrial data". Use of sensitivity analysis of results seems to be an appropriate tool for both cases to guide data collection on key processes. A second result or evidence is the current concomitance between generic multisectorial data and sector-specific data, European/word data vs. national data. Some presentations insisted on the need to develop consistent databases taking into account sector-specific requirements and local specificities. Finally, the critical issue of allocations of co-products from the production processes and end-of-life recycling was discussed but do not lead to a compromise. Indeed, this last point is likely to be more related to a political choice (share of environmental responsibilities between different systems).

Scientific presentations related to the impact assessment stage insisted on the limits of some impact assessment methods. Relevance of some methods and indicators was debated: "it is not because we understand an indicator that it has an environmental significance". For example, what is the meaning of the feedstock energy: do we need to go towards a new definition of energy consumption? Are the existing indicators sufficient to assess and compare, e.g., the construction stage and use stage? Should we consider alternative approaches, e.g., with power indicators rather than primary energy? In the same way, is it possible to reduce the number of indicators without losing too much environmental information? The existence of correlations between current indicators suggests analyzing in more details this field.

Concerning the interpretation phase, research studies proposed simplified models that focus on the key parameters of a system and take into account their variability. Other studies assessed the temporal variability in dynamic LCA models to improve the accuracy of building LCA assessment, e.g., for the electricity mix or the end-of-life scenarios. A critical issue for materials, building, and civil engineering concerns the very long service life of these systems. Scientific presentations showed the relevance of this parameter. Finally, various presentations concerned case studies that were very new as LCA topics, i.e., traditional housing in India, tunnels construction and equipment, building refurbishment, etc.

### 3.2 Overview of invited presentations

Eight speakers were invited to present their implementation of LCA depending on the field of applications: support to public policies and standardization activities, support to contracting owners, manufacturers, and construction companies. Each presentation used a common template to ensure a better comparison and to stimulate the exchanges between speakers and the audience. The template was breakdown into four main sections: LCA inside your organization, current projects dealing with LCA, encountered difficulties, and future needs.[4]

A representative of the CEN Technical Committee TC 350 opened the exchanges between researchers and practitioners by presenting the on-going standardization activities of LCA in the European construction sector. She highlighted the link between European public policies, e.g., CE marking, the new Construction Product Regulation (CPR), and the LCA related standards. To that purpose, she presented more specifically the two European standards EN 15804 "Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products" (CEN 2012a) and EN 15978 "Sustainability of construction works – Assessment of environmental performance of buildings – Calculation method" (CEN 2012b). Then, a representative from AFNOR (the French Standardization Agency) presented the national activities related to the current EPD (Environmental Product Declaration) program in France. He highlighted the process of updating the EPD program to take into account the new CEN TC 350 standards. The third invited

[4] The invited presentations can be freely downloaded from the website of the symposium here: http://lca-construction2012.ifsttar.fr/exchanges.php

presentation from the French Ministry for Ecology, Sustainable Development and Housing described a regulation project on EPD for construction products, electrical equipment, electronics, and Heating, Ventilating, and Air Conditioning (HVAC) equipment used in buildings. The project based upon current standardization activities (see above) is planned to be implemented in France from 2014. The main objective of such a regulation is to fight against "green washing" by using LCA as a basis for environmental claim. As a result, when a construction manufacturer will communicate on one or more environmental aspects of his product, he shall register an EPD in a future regulated database. This initiative is likely to foster the number of EPDs released by material producers. These three presentations enable the audience to have a practical case study of how LCA can feed public policies and standardization activities in the construction sector. Once harmonized standards are released and EPD program is operational in a country, construction stakeholders can then use LCA in their daily work.

Then, presentations were presented by four construction stakeholders including a construction owner, two construction manufacturers, and a representative of a construction company association. Table 2 presents a summary of the outcomes of their talks. We mentioned that the panel of invited stakeholders does not pretend to be exhaustive. Other bodies, not present at the conference, may also have other feedbacks on the LCA implementation in practice (e.g., architects, building owners, certification schemes for buildings, etc.).

Generally speaking, all invited speakers have started using LCA in practice. Their uses of LCA cover different needs, e.g., for improving production process (internal use), release of Environmental Product Declaration (external use), and also assessing the environmental performance of projects. The need to have public support for small and medium enterprise (SME) willing to calculate the environmental impacts of their products was also highlighted. In the same time, the publication of user-friendly LCA-based documents for stakeholders was mentioned as an efficient mean to communicate about the LCA approach to construction stakeholders.

Different encountered difficulties were highlighted such as the complexity of the LCA approach for non-specialists, the issue of LCA data collection and availability, and the allocation issue, e.g., for agriculture co-products. More generally, the presentations insisted on the need to ease the LCA results communication to construction players such as architects, engineers, and designers. A lack of a common view of a construction LCA among the different actors was also highlighted.

The future needs for these stakeholders concern different topics: improvement of the reliability of LCA results, increase of the reproducibility of LCA results by proposing, e.g., common databases for construction LCA tools, proposition of methods for interpretation, e.g., aggregation, and adapt the LCA tools to the construction practices and stakeholders.

### 3.3 Overview of round tables

Two round tables addressed both the limits of LCA applied to the construction sector and the current use of LCA based on existing knowledge.[5]

The first round table was dedicated to the limits of LCA for future research challenges. This round table discussed the current weaknesses from a scientific point of view on the application of LCA to the construction sector and address issues for its implementation. Six experts either academics or industrial researchers participated in the discussions. They had different backgrounds: experts in LCA databases for the construction sector, experts in uncertainty and data quality, etc. Different questions were raised during the round table, moderated by IFSTTAR, including topics from the goal and scope definition, inventory, impact assessment, and interpretation phases of the LCA method such as the following:

- How to take into account the uncertainty of LCA data, method, and results with its implementation in current standards (e.g., EN 15804, EN 15978) or in current regulation projects? What are the reasons for LCA results' variability?
- How to define the scope of a LCA study and its relation to the functional unit?
- How to select and/or develop suitable indicators for construction LCA, do we need localized indicators?
- How to ensure user-friendly and operational software as well as provide accurate results? How do we ensure that the LCA results are comparable among the different LCA software for the construction sector? Do we need a unified database?
- How linking methodological advances from research to standardization? Are there possible improvements?

The outcomes of this round table enabled to identify the needs for future research (see Section 4 for more information).

The second round table was dedicated to the application of LCA: knowledge transfer and best practices. This round table focussed on the decision makers and stakeholders of the construction sector. Given that standards and regulations already exist, the round table discussed how to implement the LCA into practice and how to ensure that its implementation leads to real environmental improvement. Seven experts coming from research, consultancy, institutions, industries, and companies were invited. The discussions, moderated by CSTB, were divided into several operational questions such as the following:

[5] The detailed content of the round tables as well as the names of the invited experts can be found in the program of the conference: http://lca-construction2012.ifsttar.fr/SymposiumPgm.pdf

**Table 2** Synthesis of outcomes for the invited presentations of construction stakeholders

| | LCA inside your organization | Current projects / activitie0073 | Encountered difficulties | Future needs |
|---|---|---|---|---|
| Construction owner (City Council) | No studies have been done | Sustainable development actions for city scale planning, assessment of LCA as a tool to use for decision-making (environmental aspects) | Difficulties to use LCA for city planners | LCA tools adapted for the different stages: from the design and construction phases to the maintenance phase |
| Construction manufacturer (multinational company) | LCA mainly uses in internal support (e.g., for R&D of new products, assessment of existing products) | Use of LCA internally to improve current production processes of products. | *Data* | Environmental impact: towards a global indicator? |
| | | Use of product LCA developed in the company to assess construction systems and full buildings | Difficulties to obtain reliable data on upstream processes (e.g., materials that are not manufactured by the company). Lack of data in some countries the company operates. Difficulties to get reliable metrics on bill of quantities | LCA including environmental and social impacts |
| | | | *Software*<br>Time consuming even with a LCA software, lots of impact calculation methods | Largely approved and robust LCA methodology to implement in the building market |
| | | | *Communication*<br>Need to work closely with architects / engineers / contractors | |
| | | | *Decision*<br>Lack of LCA culture for some keys actors | |
| Construction manufacturer (SME) | Participation of new LCA or Environmental Product Declaration (EPD) | On-going project aiming at calculating the EPD of three biobased products integrated in buildings: flax (particles board), hemp (concrete and insulation wool), and straw bale buildings. | *Data* | How to get value of CO2 storage during the lifetime (including recycling)? |
| | | | LCI data collection (variability of parameters due to the use of co-products from the agriculture sector), lifetime of biobased products | What is the reliability of a construction product LCA? of a building LCA? |
| Construction company association | Explain the LCA approach to construction stakeholders by writing user-friendly documents | Writing and release of operational documents explaining the use of LCA in construction projects | *Data*/*Software*/*Communication*/*Decision*<br>Lack of a common view among the stakeholders when doing a LCA of buildings (issues in data, software and results interpretation) | Requirements for researchers / tool developers: need to share a same database for impact values, same bill of quantities, need to conduct comparative assessment of LCA software for constructions |

- How to certify the LCA data that are used in construction LCA software?
- How should the critical review or the third party verification process be conducted? How to ensure the independence of the parties?
- How to adapt the LCA software for the construction sector to the needs of the practitioners (e.g., architects, design offices, companies etc.)?

The outcomes of this round table showed that the LCA approach is being implemented in practice. Discussions on the reliability of data and user friendliness of tools were judged important to increase the widespread use of LCA in practice in the future.

In the end, these two round tables linked to the eight invited presentations showed an active implementation of LCA into the construction practices even if some limitations (further discussed in Section 4) were pointed out.

## 4 Summary of findings from LCA Construction 2012

LCA Construction 2012 aimed at grouping together LCA methodologists and construction practitioners. In parallel, the conference also served as a forum of exchanges between LCA researchers from academics and industry. As shown in a recent paper (Baitz et al. 2013), maintaining a good communication between these two worlds is essential for improving the LCA method while at the same time ensuring its applicability in practice.

The scientific exchanges showed that research contributions are still needed to go towards harmonized methods fulfilling different goals and scopes of stakeholders all along the construction process. Furthermore, the exchanges with political, standardization, and industry players insisted on the fact that the LCA approach has already started to be used in practice.

We grouped below the topics discussed at the conference according to two levels of "maturity": (1) topics where consensus was found enabling implementation in practice and (2) topics where there is a need of new research.

The following aspects showed a consensus among scientists, for which implementation in practice is now needed based on the existing research works:[6]

- Increase LCA reliability, by developing specific and systematic critical reviews and verification checklists, e.g., for EPDs through the ECO-Platform initiative (ECO 2013).
- Improve reproducibility of LCA studies, and their implementation in LCA software.
- Harmonize LCA databases development for the construction sector with a planned strategy in order to reach best quality and representativeness levels (in terms of data quality and transparency).
- Harmonize LCA rules for assessing a material, a building, or an infrastructure, e.g., by means of new LCA standards such as EN 15804, EN 15978 or through operational guidance for building LCA (EeBGuide 2013).
- Improve the interpretation of results by developing benchmarks to compare buildings from localized average types or best practice.
- Develop decision-making tools and methods for construction stakeholders.
- Use of LCA in certification systems for buildings, by implementing LCA approaches in existing environmental quality labels (such as BREEAM[7], DGNB[8], HQE[9], and LEED[10] etc.).

For some of these topics, further discussions or applied research are on-going between LCA experts and construction stakeholders to ensure a correct implementation in practice. The contribution of standardization and regulation activities will help implementing and harmonizing these different aspects.

Different scientific presentations and experts round tables showed that further or new research is also needed on the following aspects:[11]

- Develop methods to adapt LCA according to the goal and scope and to the final user (adaptation of current attributional LCAs, e.g., the definition of the functional unit and the allocation rules, and development of new approaches, e.g., consequential LCAs, hybrid LCA, Economic Input Output LCA).
- Develop dynamic LCA (taking into account spatial and temporal variations) in particular for assessing the use phase of the building. For example, parameters such as the degradation of performances of construction products and technical equipment, and the precision of environmental data for energy processes for the electricity mix (hourly, monthly, and annual data) could be investigated.
- Develop research on scenarios across the life cycle of a building, e.g., according to long-term regulation and political target.
- Develop regionalized indicators, e.g., to account for resources used by the construction sector and others if relevant.

[6] The list does not pretend to be exhaustive

[7] www.breeam.org/
[8] www.dgnb.de
[9] www.behqe.com
[10] www.usgbc.org/leed
[11] The list does not pretend to be exhaustive

- Develop multi-scale LCA approaches from material assessments to buildings and city scale by relevant linking of LCA to other environmental methods (e.g., Mass Flow Analysis and Urban Metabolism).
- Develop reduced or simplified LCA models for the different scales of assessment, with the integration of uncertainty and variability (link with statistical methods).
- Integrate LCA into the Life Cycle Sustainability Analysis framework (Guinée et al. 2011) and apply it to the construction sector.

This roadmap for further discussions and research activities involving all the parties (researchers, practitioners, LCA experts, and construction scientists) can be seen as a provisional agenda of a next LCA Construction conference in the future.

## 5 Conclusions and perspectives

The LCA Construction 2012 serves as a first forum of exchanges between LCA researchers and construction scientists, academics, and industry players. The organizing committee of LCA Construction 2012 believes that such an initiative contributes to improve the knowledge transfers of recent developments and research results between the different construction stakeholders. This is also a first step before launching international and regional networks in LCA applied to the construction sector. The numerous and enthusiastic feedbacks from the participants and keynote lectures encourage thinking about a second edition in a few years.

**Acknowledgments** We would like to thank all the different sponsors for the financial support of the conference: the institutional partners such as the French Ministry for Ecology, Sustainable Development and Energy, the Pays de la Loire Region, and the Nantes Métropole and also the private companies (Bouygues construction, Lafarge, Cycleco, Cimbéton, and PricewaterhouseCoopers (PwC)).

We also thank all the people who participated in this conference (the three keynote speakers, the scientific committee, the presenters, the invited speakers, and the different experts from the two round tables).

We finally thank E. Pichot, F. Badin, A. Lalloret, J. Kerveillant, D. Grandjean-Leroux, the administrative colleagues of IFSTTAR who were part of the organization committee, J. Hans, and J. Chevalier, from CSTB for their technical and scientific support as well as all the persons at IFSTTAR and CSTB that supported the initiative.

## References

Baitz M, Albrecht S, Brauner E, Broadbent C, Castellan G, Conrath P, Fava J, Finkbeiner M, Fischer M, Fullana i Palmer P, Krinke S, Leroy C, Loebel O, McKeown P, Mersiowsky I, Möginger B, Pfaadt M, Rebitzer G, Rother E, Ruhland K, Schanssema A, Tikana L (2013) LCA's theory and practice: like ebony and ivory living in perfect harmony? Int J Life Cycle Assess 17:1–9

CEN (2012a) EN 15804: Sustainability for construction works. Environmental product declarations. Core rules for the product category of construction products. European Committee for standardization

CEN (2012b) EN 15978: Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method. European Committee for standardization.

ECO Platform (2013) www.eco-platform.org. Accessed 12 November 2013

EeBGuide (2013) Operational Guidance for Life Cycle Assessment Studies of the Energy Efficient Buildings Initiative, Online InfoHub, www.eebguide.eu. Accessed 21 November 2013

Guinée JB, Heijungs R, Huppes G, Zamagni A, Masoni P, Buonamici R, Ekvall T, Rydberg T (2011) Life cycle assessment: past, present, and future. Environ Sci Technol 45:90–96

ISO (2006) ISO 14040 Environmental management – Life cycle assessment – Principles and framework, 20 pp

Ventura A, De La Roche C (2012) Proceedings of the International Symposium on Life Cycle Assessment and construction: Civil engineering and buildings, 10-12 July 2012, Nantes, France, RILEM Publications s.a.r.l. ISBN: 978-2-35158-127-8, 416 pp